ESTIMATED COST OF ON-THE-JOB TRAINING TO THE 3-SKILL LEVEL IN THE COMMUNICATIONS CENTER OPERATIONS SPECIALTY

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June 1972

AIR FORCE HUMAN RESOURCES LABORATORY

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AIR FORCE SYSTEMS COMMAND

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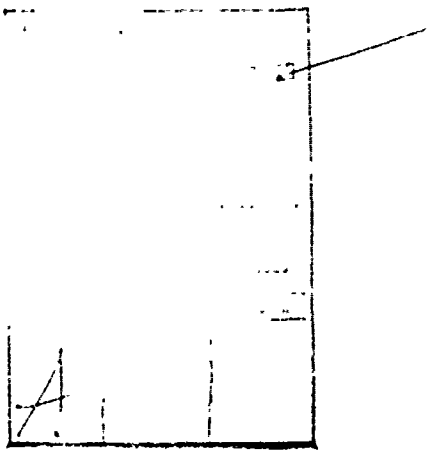

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I-C

FOREWORD

This research was completed under Project 6323, Personnel Management Research and Development; Task 632302, Research and Development on Mathematical/ Econometric Models of the Air Force Personnel System.

This report describes the preliminary results of an effort to develop a methodology for estimating costs of On-the-Job Training which can be used in decisions concerning optimal mixes of OJT and Technical School.

This report has been reviewed and is approved.

George K. Patterson, Colonel, USAF
Commander

ABSTRACT

Decisions concerned with the use of alternative Air Force training methods require several types of data. Among these are capacity to train, cost of the training, and quality of the trained airmen. The two methods of formal training in the Air Force are on-the-job training (OJT) and technical school training. The data currently being provided to decision makers for selecting the proper mix of these two training methods can be substantially improved.

A model to obtain cost data for technical training school already exists. This study applies a methodology developed to estimate the cost of OJT to the 3-skill (semi-skilled) level for Air Force Specialty 291X0, Communications Center Operations, and compares it with the cost of the corresponding technical training school course, 3ABR29130.

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ESTIMATED COST OF ON-THE-JOB TRAINING TO THE 3-SKILL LEVEL IN THE COMMUNICATIONS CENTER OPERATIONS SPECIALTY

I. INTRODUCTION

> "The training system must be critically evaluated to reduce cost in terms of money and manpower and yet produce trained personnel in the numbers required (*USAF Personnel Plan*, Vol I, para 2-2-3, June 1971)."

The United States Air Force trains approximately 80,000 non-prior-service airmen each year. After completion of basic training, 53 percent of the new airmen are assigned to Category A specialties to upgrade through a technical training school course; 43 percent are assigned to Category B specialties where they may go to a technical training school or they may upgrade through on-the-job training (OJT); 4 percent are assigned to Category C specialties to upgrade only through OJT.[1] The Air Force programmed an average of 51 percent of the airmen in Category B skills to technical training school and 49 percent to OJT in FY 1971.

The cost of training the required personnel in Category B specialties can be altered by varying the relative use of technical training school and OJT. The OJT-technical school mix may also affect the quality of trained airmen, the time necessary to meet a sudden increase in required operational capability, and the ability of units to maintain their operational effectiveness. Thus, the problem of selecting an optimal mix for any Air Force specialty calls for detailed information in several areas.

One necessary data input is the cost of OJT. The primary purpose of this study was to develop and apply a methodology for obtaining useful cost estimates of OJT for Category B Air Force specialties. With such information, the cost of OJT can be compared to the cost of the corresponding technical training course, and an optimal mix of the two training approaches for the specialty under consideration can be determined.

[1]These percentages, obtained from FY 1971 *Programmed Technical Training*, ATC, DSC/TT, may fluctuate slightly over time.

II. DESCRIPTION AND COLLECTION OF DATA

Description of Specialty to be Studied

The Air Force specialty selected as the subject of this initial study was Communications Center Operations, Air Force Specialty Code (AFSC) 291X0. The primary manual skill needed for this specialty is high-speed typing on a wide variety of equipment consoles. Since personnel within the specialty move messages worldwide for the Air Force, the procedures, codes, and message formats which must be learned are complex. Moreover, the procedures and formats vary greatly depending on which of the two dozen types of equipment are used in the more than two hundred centers within the continental United States (CONUS).

The Communications Center Operations specialty is described as an imbalanced AFSC, which means that there is a greater requirement for this skill overseas than in the CONUS. Also, since entry into a communications center usually requires that the individual have a security clearance, a trainee may encounter a few weeks' delay before beginning OJT.

In addition to OJT (which is described in brief and general terms in Appendix I), training in this specialty is provided through enrollment in technical training course (3ABR29130) at Sheppard Air Force Base, Texas.

Identification of Cost Factors

Several general cost factors were identified which would encompass all of the costs associated with Air Force OJT and would be relevant for all Air Force specialties. The factors include student time, instructor time, records management, remedial training, and equipment and materials. For a more detailed discussion of this aspect of the study, see Appendix II.

Because several of the cost factors measure the cost of time, it was necessary that data be collected in the form of time or dollars, or both. If data had existed on OJT, it might have been possible to estimate the cost directly in dollars. However, after an extensive research of Department of Defense, Federal, and professional

material to determine if any information of this sort existed for OJT. None was found.[2] Therefore, a technique had to be developed for collecting the appropriate data in suitable measures.

Development and Administration of OJT Survey

Three techniques for data collection were considered: establishment of a recording system for OJT data, conduct of a large number of interviews, and administration of a survey. The recording system would require a long lead time and would be burdensome to operational units, but it could be very accurate. The interview method would also require a lot of time and it would cost more for the transportation that would be involved, but it, too, could be fairly accurate—depending on the interviewer. A survey would have the disadvantage of being relatively less accurate than the other two approaches, but it would have the advantages of being less costly per observation and less time consuming for the researcher and the respondents. The survey would also have the advantage of visibility—a critic could look at a survey instrument and judge it, whereas it would be difficult to critique interviews after the fact. Hence, the survey technique was used.

Surveys were mailed to 214 addresses in the CONUS only. Although approximately 12.5 percent of OJT to the 3-skill level is being conducted overseas,[3] most of these trainees are probably lateral or cross-trainees from another specialty and, therefore, are generally atypical of trainees learning the 291X0 specialty as their first skill.

Initial interviews were conducted with four supervisors at communications centers at Lackland Air Force Base, HQ Security Service, and Kelly Air Force Base, Texas. Although Security Service uses personnel with the 291X0 AFSC, the operations in Security Service communications centers are significantly different from those of the usual base communications center. Therefore, Security Service subjects were excluded from the sample because their responses would have tended to describe atypical training.

An initial survey design was completed after the interviews, followed by final design of the cost factor equations. The initial survey was then administered to the communications center supervisors at Kelly, Randolph, and Brooks Air Force Bases. This provided feedback on survey design and information to use in the equations (see Appendix II) as a test run.

A copy of the Communications Center Operations OJT Survey is presented as Appendix V. Of all the questions on the survey, number 18 was the most difficult to design—and, correspondingly, the most useful as an input into the equations. It was designed to collect the majority of information about time spent by instructors and trainees in OJT. The problem was choosing the appropriate units of time and degree of detail. These choices were dependent upon several factors: the actual time phasing of the training, the ability of supervisors to give accurate information under the various possibilities for units of time, and the ability of supervisors to mentally join together related groups of skills when answering the question. The decision was to use the Specialty Training Standard (STS) as a general format because each respondent would be familiar with its terminology and method of grouping skills. The question of the appropriate unit of time was resolved by asking for estimates of the hours per week spent within training weeks. The rest of the survey questions were fairly straightforward.

Some surveys were partially filled out, while others were completely filled out but with inconsistent data. These latter surveys were identified to prevent their use in computation of the cost factor equations.

Of the 214 surveys mailed, 113 were returned completely filled out, and 104 of these were judged to be consistently completed. These 104 cases were used for the final cost estimate. Some of the partially completed surveys were used to obtain averages for the first 17 questions.

III. ANALYSIS OF RESULTS

Summary of Survey Responses

Equations designed to represent the OJT cost factors are specified in detail in Appendix II. The value of each of these equations was computed for each valid survey. Table 1 shows the means and standard deviations of the cost factor estimates computed from equations derived from the 104-case sample.

[2]The time to 3-skill level reflected by an airman's records is a poor estimate of the actual time to skill level for several reasons: minimum time to skill level requirements have been prescribed administrative delays in records processing sometimes exist, and data recording errors can occur. The Air Force keeps very little OJT data beyond a record of the date that a new skill level is attained.

[3]Determined from the Uniform Airman Record, December 1970.

The high standard deviation of the cost estimates reflects three things: the variance in complexity of tasks at different communications centers, the quality of the trainee observed, and the variance in supervisors' perception of the time required for OJT to the 3-skill level.[4]

The total cost estimates illustrated in the histogram shown as Figure 1 are skewed to the right. Therefore, the median may be a more appropriate measure of central tendency than the mean because the mean biases the results by placing too much emphasis on a few large cost estimates.

The median total cost estimate is $1,311 with a 95 percent confidence interval of:

$$\$1{,}108 \leq \text{Median Total Cost} \leq \$1{,}515$$

In other words, there is 95 percent confidence that the median total cost of OJT to the 3-skill level is between $1,108 and $1,515.

Table 1. **Mean OJT Cost Factors Computed from Equations Derived from Survey Responses**
(N = 104)

Cost Factor	Mean	SD
Student Time	$ 615	516
Indirect Cost of OJT	19	---
Instructor Time	412	460
Delayed Entry Into Training	259	232
Records Management	110	121
Remedial Training	30	82
Equipment and Materials	8	---
Average Total Cost	$1,453	842[a]

[a]Computed using the sums of cost factor equations for each survey as observations.

[4]One could advance the hypothesis that this relatively large variance is caused by other variables such as unit size or complexity of equipment. A short investigation of this hypothesis is discussed in Section IV.

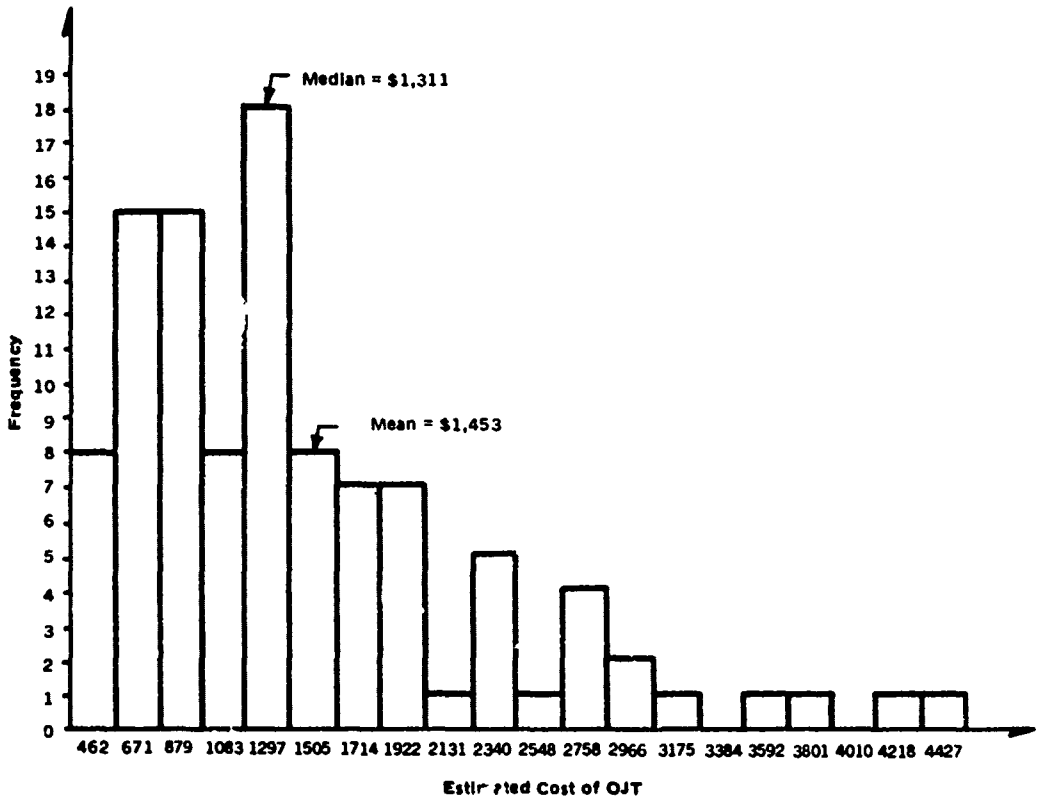

Fig. 1. **Frequency of OJT cost estimates derived from survey responses.**

Table 2. **Summary Statistics for Responses to Survey Questions 1 through 17**
(Survey Administered March 1971, N = 153)

Survey Item Number	Content of Item	Mean	SD	Total	Percent
1.	Number of months since OJT to 3-level last conducted	10.70	9.295		
2.	Average number of weeks between arrival of DDA and start of training	3.41	3.777		
3.	Average number of weeks between arrival of tech school 3-level and start of 5-level training	2.09	1.132		
4.	Average number of weeks to 3-level for DDA	10.89	7.032		
5.	Proportion of 3-level trainees failing Advancement Knowledge Test the first time	0.11	0.200		
6.	Average number of shifts per day for operation of communication center	3.01	0.406		
7a.	Number of trainees currently going to 3-level			67	
7b.	Number of trainees currently going to 5-level			167	
8.	Number of additional trainees to 3-level which could be handled if unit were allowed to go over manning authorization			510	
9.	Number of additional trainees to 3-level which could be handled if unit lost a 5-level for each new trainee			267	
10a.	Number of instructors, E-7			15	3
10b.	Number of instructors, E-6			85	15
10c.	Number of instructors, E-5			297	52
10d.	Number of instructors, E-4			156	27
10e.	Number of instructors, E-3			15	3
11a.	Percent OJT-trained 3-level workload that can be handled by newly arrived tech school 3-level	32.16	21.221		
11b.	Number of weeks until workload capacity of tech school 3-level reaches that of OJT-trained 3-level	4.25	2.664		
11c.	Consider either type of training superior to the other			85	56
11d.	Consider OJT-trained 3-levels superior to tech school 3-levels			25	16
12a.	Average number of weeks remedial training, when given	2.64	2.507		
12b.	Average trainee hours per week, on duty, remedial training	6.61	7.629		
12c.	Average instructor hours per week, on duty, remedial training	4.92	6.043		
12d.	Average trainee hours per week, over-time, remedial training	3.22	4.838		

Table 2 *(Continued)*

Survey Item Number	Content of Item	Mean	SD	Total	Percent
12e.	Average instructor hours per week, overtime, remedial training	1.36	2.937		
12f.	Average grade of remedial training instructor	3.11	2.535		
13.	Percent trainees failing to upgrade to 3-level in the last year	0.00	0.011		
14.	Average instructor hours per week spent in records keeping	1.30	1.920		
15a.	Average monitor hours per week spent in records keeping	0.86	1.231		
15b.	OJT monitor's grade	4.99	1.784		
16.	Percent Career Development Course relevant to operations of unit	45.57	25.396		
17.	Total number of personnel in unit	23.30	58.085		

Table 3. **Summary Statistics for Selected Training Items in the Specialty Training Standard Derived from Responses to Survey Question 18**

Training Item	Equation Notation	Trainee Hours		Instructor Hours		Instructor-to-trainee Mean Ratio
		Mean	SD	Mean	SD	
Mission	$Y_{1,j}$	7.59	24.10	2.77	4.52	.71
Comm Security	$Y_{2,j}$	24.84	32.48	9.82	12.88	.70
Safety	$Y_{3,j}$	5.42	6.32	2.47	4.22	.71
Publications	$Y_{4,j}$	30.09	49.59	10.52	17.81	.69
Typing	$Y_{5,j}$	55.01	61.01	13.75	16.71	.66
Comm Instructions	$Y_{6,j}$	61.87	85.20	22.11	43.15	.69
Crypto Ops	$Y_{7,j}$	19.86	41.49	9.97	29.17	.71
Routing	$Y_{8,j}$	25.80	51.55	8.64	15.42	.72
Services	$Y_{9,j}$	27.87	38.20	11.24	19.51	.71
Incoming Narrative	$Y_{10,j}$	18.56	28.98	6.45	11.29	.64
Incoming Data	$Y_{11,j}$	14.10	22.69	5.36	11.10	.59
Outgoing Narrative	$Y_{12,j}$	26.69	41.82	7.65	12.18	.61
Outgoing Data	$Y_{13,j}$	16.36	30.84	6.02	12.52	.51
Inspection	$Y_{14,j}$	21.58	119.92	3.85	8.90	.46
Processing	$Y_{15,j}$	11.61	20.25	3.98	9.27	.45
Routing	$Y_{16,j}$	11.06	22.75	4.24	10.11	.44
Transmission	$Y_{17,j}$	8.96	17.53	3.46	8.95	.45
Autodin SW Center	$Y_{18,j}$	26.76	74.16	9.55	34.18	.36
Tel Switchboard Ops	$Y_{19,j}$	51.77	62.12	22.31	42.65	.66

Descriptive statistics summarizing the responses to the first 17 questions on 153 surveys[5] are presented in Table 2 Statistics for question 18 are summarized in Table 3.

[5]These 153 surveys include the 113 completed surveys plus 40 partially completed surveys.

The survey produced several interesting results in addition to the cost estimate. For instance, the mean value given for question 2 indicates that the average unskilled directed duty assignee (DDA) waits three to four weeks before beginning OJT. The delay in entry to training primarily reflects the time needed to obtain the security clearance

which is required for entry to most communications centers. This delay, in turn, results in a three- to four-week loss in productivity after completion of OJT. An estimate of this value is included in the cost estimate for OJT.

The mean value for question 4 implies that the average time in OJT for proficiency qualification at the 3-skill level is approximately 11 weeks, whereas the technical training course is 12 weeks long.

The answers to questions 8 and 9 suggest that supervisors could train many more personnel on the job if they were sent DDA in a "pipeline" status. That is, if supervisors could identify personnel losses a few months ahead of time and procure and train new DDAs before the qualified 5-levels were lost, the capacity for OJT in this skill could be substantially increased.

The difference between questions 7a and 9 reflects excess OJT capacity which could be utilized without changing the present assignment system.

The mean values for questions 11a and 11b highlight the fact that the new technical school graduate, a qualified 3-level, does not have the productivity of an OJT-trained 3-level until more than four weeks after his arrival at the communications center. This information is incorporated into the cost estimate for technical training school.

The percentage values for questions 11c and 11d indicate that 44 percent of the supervisors surveyed (N = 153) feel there is no difference in the performance of OJT-trained 3-levels and technical school graduates, while 16 percent think that OJT-trained 3-levels have better performance, and 40 percent believe that technical school graduates are better qualified. These figures can be misleading because it is difficult to prove that supervisors' answers were guided only by their assessment of performance quality. In other words, instructors may have based their answers upon a preference for a training method rather than upon a preference for the output of that training method–a qualified 3-skill level airman. Thus, these data are inconclusive. It is doubtful that a question or series of questions can be designed to provide unbiased information concerning supervisors' opinions regarding the comparative performance of OJT 3-levels and technical training school 3-levels.

The mean value for question 16 implies that, on the average, one can expect that less than 50 percent of the material in the Career Development Course will be applicable to the operations of a particular unit. This is not necessarily a bad point, however, because the trainees will be assigned during their career to various communications centers with different kinds of equipment. On the other hand, the finding could provide slight support to a hypothesis that training received in technical training school is in excess of that actually needed for operations in the field.

Cost of Technical School Training

Course 3ABR29130 at Sheppard Air Force Base Technical Training Center corresponds to OJT to the 3-level in the 291X0 specialty. Using a computer model, RAND Corporation provided a cost estimate for this course (Allison, 1970). Costs included in the model contain data corresponding completely with the OJT cost factors listed in Table 1. A detailed breakout of the technical school course cost elements is presented in Appendix III. The resulting estimated cost per graduate of $2,670 for FY 1970 does not take into consideration the OJT at the unit of assignment that is necessary to bring the technical school graduate up to the workload capability of an OJT-trained 3-level.

An accurate estimate of the cost of this additional training would require a large-scale effort and is not justified considering the relative size of the cost. However, an estimate of the student and instructor cost of this phase of OJT was obtained using a method of extrapolation described in Appendix IV. Results indicate that an additional student time cost of $33 and an additional instructor time cost of $77 would be incurred in order to increase the proficiency of a 3-level technical school graduate to the same level of proficiency as that of an OJT-trained 3-level. Therefore, the adjusted cost of technical school training is $2,780.

Comparative Cost of Technical School Training and OJT

The adjusted cost of technical school training reported in the previous section is 112 percent higher than the median OJT cost estimate of $1,311. If the upper limit of the OJT 95-percent confidence interval ($1,515) is compared with the cost of technical school training ($2,780), it becomes apparent that the cost of technical school is 83 percent higher than OJT. Most of this difference is largely attributable to equipment, maintenance, training aids, and administration costs which do not measurably exist for OJT.

This cost difference does not reflect a difference in the quality of the two methods of training, nor is it necessarily indicative of expected relative training costs for other specialties. (The question of comparative quality is treated separately.) If the two methods of training produce equally qualified airmen, the relative costs would seem to indicate that the Air Force should send as many personnel as possible to OJT in this skill, subject to manning constraints.

Comparative Quality of Technical School Training and OJT

This section considers two questions of quality—input and output. First, input. If the two populations of airmen who entered the separate training systems were of different quality and if this affected their training progress, then the cost comparison would have uncertain implications. Airmen entering the 291X0 career field must have a score of 60 or better on the Administrative or the General Aptitude Index (AI) of the Airman Qualifying Examination (AQE). Observation by supervisors and instructors of high (or low) quality airmen could bias the OJT cost estimate. Data on the Administrative and General AIs, presented in Table 4, were used to examine this question.[6] From the table, it appears that OJT trainees represent a slightly higher quality of input; however, the differences in mean AQE scores were not large enough to result in a noticeable difference in the quality of airmen as observed by supervisors during OJT.

Table 4. **Comparative Performance of Technical Training School and OJT Trainees on AQE Administrative and General Aptitude Indexes**

Training Method	Admin AI		Gen AI	
	N	Mean	N	Mean
Tech School	707	74.08	710	40.90
OJT	191	74.18	193	42.80

The next question is: How "good" are the training methods with respect to their outputs, the trained airmen? The proper way to answer this question is to measure and compare the productivity of the airmen coming from the two different training methods. Unfortunately, productivity measures useful for this purpose do not now exist for most Air Force skills. An alternative measure of the quality of the two methods of training is performance on the Specialty Knowledge Test (SKT). The SKT is a skill-specific paper-and-pencil test administered to airmen desiring promotion. An SKT can only test the examinee's knowledge of operations, not his actual manual skill, dexterity, and ability to produce on the job. The data presented in Table 5 represent a measure of each training method's success in teaching the required knowledge.[7]

Table 5. **Comparative Performance of Technical Training School and OJT Trainees on 2914 and 2915 Specialty Knowledge Tests**

Training Method	2914 SKT			2915 SKT		
	N	Mean	SD	N	Mean	SD
Tech School	514	42.23	9.06	239	45.95	9.57
OJT	130	41.57	8.82	108	47.37	10.20

As is apparent in Table 5, the differences in SKT scores for OJT and technical school trainees were small and not statistically significant at the .01 level for either the 4-level or the 5-level SKT for Communications Center Operations. It can be inferred from these results that technical school and OJT methods teach the required course material equally well for this career field.

[6] Data were from matching records on a selected merge of the December 1970 Uniform Airman Record and the March 1970 Project 100,000 file, both maintained at the Personnel Research Division. All airmen in this sample enlisted at the same time between December 1968 and March 1970. The Project 100,000 file provided data on whether personnel went to technical training school or to OJT after basic military training; the Uniform Airman Record provided percentile AQE scores, which were transformed back into percent correct from which the mean scores were computed using the grouped data method. Project 100,000 is a random sample, by AFQT mental category, of the airman population. Although still representative of the population, the sample sizes in Table 3 are much less than the total number of airmen who took the tests between 1968 and 1970.

[7] These data were taken from matching records on a selected merge of the March 1970 Project 100,000 file and the July 1971 Truncated WAPS Test Analysis file, both maintained at the Personnel Research Division. The Project 100,000 file provided data on whether personnel went to technical school or to OJT after basic military training, and the WAPS Test Analysis file provided percentage of correct SKT answers. All scores were for the same test edition date and represented the total population of airmen who took the 2914 and 2915 SKTs between December 1968 and March 1970.

Sensitivity Analysis

This section briefly considers the changes in the estimated cost of OJT which would result from changes in some key variables.

The percentage of students who are given remedial training could increase if the Advancement Knowledge Test failure rate increased. Answers given to question 5 in the survey indicate that 11 percent is the average failure rate. If this rate were to increase to 20 percent as a result of lower quality personnel, the cost of remedial training would be increased by 9 percent, from $30 to $33.

Another variable which could change is the instructor-to-student ratio. The average value obtained from the surveys was .60. If only one student were sent to a communications center, the ratio would obviously become 1.00. This would increase the per-student cost of instructor time by roughly 40 percent which would, in turn, increase the total cost estimate by $165, from $1,311 to $1,476.

Similar computations can be easily performed because all costs are linear with respect to student load. Changes in the value of any key variable would have a linear impact on all the cost factors in which it appeared.

An interesting question is the relationship of OJT costs to the size of the communications centers. To the extent that the instructor-to-student ratio can be lowered, the cost of instructor time can be lessened. However, large communications centers tend to have more equipment and more complex operations than smaller centers, a fact which could increase the trainee's time to proficiency and, thereby, increase the OJT cost. On the other hand, upgrading students by OJT in large communications centers might result in a better qualified airman. Thus, the direction and magnitude of the relationship between unit size and OJT costs cannot be determined without more detailed data collection and analysis.

IV. DISCUSSION

OJT is not identical for all CONUS communications centers because of varying missions, equipment, and procedures. This statement is supported by the response to survey question 16 which indicates that, on the average, only 47 percent of the Career Development Course is relevent to the operation of any individual communications center. Such variability in OJT subject matter could make an OJT cost estimate difficult to interpret.

To correct for this possible distortion of the related findings, survey question 18 was structured so that supervisors (*i.e.*, the survey respondents) could leave blank those parts referring to operations not conducted at their individual units. The supervisors did, in fact, frequently leave blanks or indicate that parts of question 18 were not applicable. Thus, breaking down the time estimate in the manner of question 18 had the advantage of being specific enough to allow for variation in unit operations, while not being so detailed that the respondent was forced to give spurious answers to minute details he could not recall.

The relatively large degree of variation in unit operations could have been responsible for some of the variation in estimated unit cost of OJT. This variation is emphasized by the estimate of mean time to reach the proficiency required of a 3-level: 11 weeks, with a standard deviation of 7 weeks, and a response range of from 6 to 20 weeks.

Continued use of this cost estimate in the future is valid only to the extent that future knowledge and skill requirements in this specialty correspond to the knowledge and skills required when the cost estimate was made. The equipment, procedures, and formats used in communications centers have varied over the years. These system changes required that experienced personnel participate in a continuous learning process. This continual flux of knowledge does not appear to alter the time to the 3-skill level for a new worker, however. Thus, the data collected should be valid at least for the near future—say, five to ten years. Any radical change in the Communications Center Operations specialty, of course, would require a reevaluation of the relevance of this cost estimate.

Correlation coefficients were computed to determine the degree to which some variables might be related to the cost estimates obtained from the survey data. These relationships are shown in Table 6.

A priori reasoning might cause one to expect larger correlation coefficients (in an absolute sense) for many of the variables. For instance, communications centers with a relatively large number of equipment consoles might be expected to have more training time and, thus, report a higher OJT cost. It could be that none of these variables is related to the cost of OJT. Another

Table 6. **Correlation between Estimated Cost of OJT and Selected Variables**
(N = 104)

Variable	r
Number of 3-level trainees in unit	.0461
Number of 5-level trainees in unit	.0716
Total number of 3- and 5-level trainees	.0690
Months since OJT last conducted	−.0870
Percent of Career Development Course relevant to unit operations	.2083
Number of equipment consoles	−.0084
Time to 3-level (OJT)	.1008
Total number of personnel in unit	−.0376

possibility is that none of these variables affects the supervisors' estimates of the time involved in OJT. A final possibility is that the size and randomness of the supervisors' perception of student and instructor time spent with OJT overwhelms the strength of the expected relationships. Followup studies will examine this question in more detail to attempt to eliminate any unreliable (error) variance.

The survey used to collect the OJT cost data required for this study produced acceptable results. However, there are alternative ways of asking similar or related questions which should be examined.[8] Cost estimates obtained through alternative approaches could be compared in terms of bias, minimum variance, or some other suitable measure to select techniques most useful for estimating the cost of Air Force OJT.

V. CONCLUSIONS

Compared to the techniques developed in this study, there are more complex, perhaps less readily understandable techniques for estimating the cost of and returns to OJT (Mincer, 1962). The assumptions necessary for use of such techniques could render the resulting estimate difficult to use. In addition, the time constraints faced by managers may require the use of available data for an immediate estimate. Forcing questionable data through a complex methodology requiring sensitive assumptions may result in a cost estimate that is difficult to interpret. The simple concepts outlined in this study are quite visible. That is, it would be easy to pinpoint the cause of an uncertainty and interpret its effect on a cost estimate which used the methodology.

On the basis of the Specialty Knowledge Test scores of the airmen in the sample studied, both the technical school and the OJT training approaches appear to produce equally well-qualified airmen for the Communications Center Operations specialty. Another finding indicates that the cost of technical school training is approximately twice that of on-the-job training.

It should be noted, however, that these results do not necessarily imply that the cost of OJT will be less than the cost of technical training school for all Air Force specialties. Furthermore, the results are not justification for discontinuing the technical school course for Communications Center Operations. The data do suggest that the Air Force should send as many personnel as possible to OJT in this particular skill, although the exact number or percentage of the training requirement who should upgrade through OJT is not specified.

There are five criteria relevant to determining an optimal mix of OJT and technical school training in any Air Force specialty:

1. Cost of technical school training
2. Cost of on-the-job training
3. Quality of training methods
4. Capacity of training methods
5. Personnel assignment system constraints

The present analysis considers only the first three of these criteria. Information is needed concerning the last two criteria to determine an optimal combination of the two training methods.

Finally, this study provided empirical evidence which strongly supports two hypotheses. One is that the Air Force can obtain realistic, useful cost estimates of on-the-job training at reasonable expense for use in decisions which allocate millions of dollars each year. The second is that there may be a striking difference between the cost of OJT and the cost of technical training school for several Air Force specialties. The cost difference found for Communications Center Operations is not some imaginary, hard-to-grasp concept—it represents real manpower and materiel resources. Improved allocation of these training resources in Category B specialties would allow the Air Force to improve its operational capabilities in several career fields without increasing costs.

[8] As an example, consider the method by which time-path estimates are obtained for PERT—Program Evaluation and Review Technique (MacGrimmon, 1964).

REFERENCES

Allison, S.L. A computer model for estimating resources and costs of an Air Force resident technical training course, WN-7044-PR. Santa Monica, Calif.: Rand Corporation, October 1970.

MacCrimmon, K.R. & Ryavec, C.A. An analytical study of the PERT assumptions. *Operations Research*, 1964, **12**, 16-37.

Mincer, J. OJT: Costs, returns, and some implications. *Journal of Political Economy*, October 1962.

BIBLIOGRAPHY

Arzigian, S. *On-the-job training costs: An analysis.* WRM 67-52, AD-656 581. Naval Personnel Program Support Activity, Naval Personnel Research Laboratory, 1967.

Bateman, C.W. *Formal and On-the-Job training in military occupations.* Unpublished staff report. Office of the Secretary of Defense: Washington, D.C.

Becker, G.S. *Human capital.* New York: Columbia University Press, 1964.

Fisher, G.H. *Cost considerations in systems analysis.* R-490-ASD. Santa Monica, Calif.: Rand Corporation, 1970.

Investment in Human Beings, *Journal of Political Economy*, No. 5, Part 2 Vol. LXX, October 1962.

Lieberman, B. *Contemporary problems in statistics.* New York: Oxford University Press, 1971.

Mincer, J. Investment in human capital and personal income. *Journal of Political Economy*, August 1958, 281-302.

Morgan, J., & David, M. Education and income. *Quarterly Journal of Economics*, 1963, **77**, 423-437.

Shultz, T.W. Investment in human capital, 1961, AER Vol. 51, 1-16.

Shultz, D.G., & Siegel, A.I. Post-training performance-criterion development and application. *A selective review of methods for measuring individual differences in on-the-job performance.* Wayne, Pennsylvania, Applied Psychological Services, July 1961.

APPENDIX I. DESCRIPTION OF ON-THE-JOB TRAINING

As described in Air Force Manual 50-23, *On-the-Job Training*, OJT in the Air Force is regarded as a formal method of training which can be used by an operational unit to upgrade enlisted personnel to the knowledge and proficiency required for a specific specialty and skill level.

The OJT program operates under the "Dual Channel" concept. That is, a trainee acquires both career knowledge and job proficiency during the course of the training. Career knowledge is obtained primarily through the Career Development Course–a programmed course of instruction containing specific skill information learned through self-instruction, both on the job and off duty, and by daily discussion with a trainer. These courses and their associated tests are updated frequently.

Job proficiency, the second channel, is acquired by the trainee through instruction, practice, and actual performance of the skills. Progression of the trainee in acquiring skill proficiency is carefully monitored by updating the Special Training Standard, or Job Proficiency Guide. This is a form specific to each Air Force specialty which details the skills, the required level of proficiency for each skill, and verification by the trainer that the trainee has the required proficiency.

Satisfactory completion of job proficiency training, the Career Development Course, and the Advancement Knowledge Test, plus supervisor recommendation, results in the airman's being upgraded to the 3-skill level (semi-skilled) in his specialty.

APPENDIX II. COSTING OJT

It would be desirable if the Air Force employed skills with easily measured outputs to which a value could be assigned. However, it is often the case that the output of a skill is not easily related to an absolute measure. For example, the protection afforded by the Security Police's patrolling of a flight line would be considered an output. In this instance, though, what measurement scale could be used to assign a number to "protection" to indicate its value?

Given that some outputs are not directly quantifiable, one can move back a step in the production process and use the inputs as substitute (proxy) variables to measure the value of output. The logic for this is that although it is difficult to place a value on output, Air Force decision makers must consider the output of the skill, *e.g.*, Security Police, at least as valuable as the manpower and equipment used in the skill.

Since the economic cost of any type of training is the value foregone as a result of the training, the cost (opportunity cost) of OJT in terms of inputs may be considered in two broad areas: (*a*) materials and equipment, and (*b*) student and instructor time. These two areas can represent the resource inputs, and thus the output, foregone in order to conduct OJT.

The product of the OJT process is a skilled airman. Thus, the cost estimate, according to the criteria discussed earlier, should be in units of cost per skilled airman. This ties the cost estimate to a specific output; for instance, the estimate could be for the cost of one OJT-upgraded, 3-skill level Fire Protection Specialist.

The two broad areas of cost can now be separated into components for ease of analysis:

Time spent instructing. This is the time which trainer (instructor) must spend with a trainee to describe and demonstrate the performance of each skill in which the trainee is required to become proficient.

Time spent in remedial training. This is the time spent by the instructor during duty hours which is devoted to bringing the trainee's knowledge up to the required level of proficiency when a trainee fails a paper-and-pencil skill test given at the end of his correspondence course.

Time spent in records management. This is the time taken out of each training week in order to review and update one trainee's records. Both instructors and unit OJT monitors spend time here.

Time spent by the student in OJT. This includes reading of course materials, practice of skills (as opposed to productive work), and time spent with instructors to learn the skills.

Student time spent in remedial training. If the trainee fails an end-of-course correspondence test, he must review the course materials with an instructor and retake the test. This review work is often done on the job.

Materials and equipment. This component refers only to materials and equipment used solely for OJT and which are non-reusable. This might include such items as course materials, additional equipment maintenance, gasoline, and munitions. The concept here is to consider only those costs which are incremental, or in addition to the equipment normally required by unit operations.

Indirect cost of student time. In addition to the unit instructors and OJT monitors, organizations exist at base and command levels which also monitor the progress of trainees, thus incurring a cost due to the existence of OJT, but not attributable to a specific skill.

Often organizations, operations, or jobs exist at a base because OJT is conducted at that base. For instance, Air Training Command keeps very tight control of its OJT programs by maintaining centralized administration of trainees' progress, course materials, testing, and counseling. Thus, for any specialty under ATC control, the indirect cost of OJT would be some sort of per-trainee estimate of the cost of this control monitoring agency for each ATC base.

However, most of the OJT functions for AFSC 291X0, including records maintenance, are handled by the individual unit. The only contact outside the unit is when the Specialty Knowledge Test or end-of-course examinations are administered by the local personnel office. Thus, base overhead is minute on an individual trainee basis. This is also true of command overhead.

An indirect cost not reported as such for this skill is the administration of the Career Development Course and course materials. The size and complexity of the Extension Course Institute, which prints and administers the courses, prevents allocation of costs to any single skill. It was felt that it would be simpler to report this cost under the single heading of *Equipment and Materials* rather than break up this small number. Therefore, for this skill the percentage of total cost falling under the category of *Indirect Cost* is very small. This particular cost factor will probably vary greatly among specialties, depending upon how the training is administered.

Output from the technical school cost estimate, included in Appendix VI, indicates that the annual cost of updating course materials for the 291X0 Air Force specialty is approximately $37,200. This cost, distributed among the two-thousand or more trainees who benefit each year, comes to $18.60 per trainee. This cost is also included in the estimate reported for technical training school.

The specific makeup of any of these cost factors will vary from skill to skill. For instance, some skills may have a large number of items in *Materials and Equipment,* while others (*e.g.*, paper-and-pencil skills) may have a negligible value for this cost factor.

Breaking up the total cost estimate into these categories will reduce the complexity of the overall analysis and provide a more accurate estimate without going into unmanageable detail. An added advantage is that the separate factors make the estimate easier to critique and easier to understand.

An important aspect of any study is selection of an appropriate measurement scale. The measurement scale used for estimating the cost of OJT should be dollars, for two reasons. One, most resource allocation decisions in the Department of Defense, especially at lower levels of decision making, require explicit discussion of the impact of an alternative in terms of dollars. The second reason is that the dollar, particularly with treatment of uncertainty, is the best understood, least ambiguous measure currently available.

For the purposes of this study, trainees were assumed to hold grade E-2 and 3-levels grade E-3. The number of annual work hours for all communications center personnel was assumed to be 2,080 hours (*i.e.*, 52 weeks times 40 hours per week).

The cost factor equations are presented here in the form actually used for computation. The X_i variables represent the 31 answer blanks in the first 17 questions on the survey, respectively. The Y_{ij} variables represent question 18 where i = 1, 2, . . . 19 and j 1, 2, . . . 5. For instance, $Y_{4,2}$ is the number representing trainee hours per week reading spent learning publications in question 18.

Cost of Delayed Entry into 291X0 Training

$$\left(\begin{array}{c}\text{Number of weeks}\\ \text{between arrival of}\\ \text{DDA and start of}\\ \text{Training}\end{array}\right) \bullet \left(\begin{array}{c}\text{Hourly wage of}\\ \text{upgraded 3-level}\end{array}\right) \bullet \left(\begin{array}{c}\text{Work}\\ \text{hours}\\ \text{per week}\end{array}\right) =$$

$$(\text{Question 2}) \bullet (\$1.62) \bullet (40) = \frac{\$}{\text{Trainee}}$$

Cost of Records Management

$$\left[\frac{\sum_{i=3}^{7} \left(\begin{array}{c}\text{Number of instructors}\\ \text{with grade } i\end{array}\right) \bullet \left(\begin{array}{c}\text{Hourly wage of}\\ \text{instructors with grade } i\end{array}\right)}{\sum_{i=3}^{7} \text{number of instructors with grade } i}\right] \bullet \left(\begin{array}{c}\text{Instructor hours}\\ \text{per week spent}\\ \text{in maintaining}\\ \text{trainee's records}\end{array}\right) \bullet$$

$$\left(\begin{array}{c}\text{Average time}\\ \text{to skill level}\\ \text{in weeks}\end{array}\right) + \left(\begin{array}{c}\text{Hourly wage of}\\ \text{unit OJT monitor}\end{array}\right) \bullet \left(\begin{array}{c}\text{Hours per week}\\ \text{spent by OJT}\\ \text{monitor}\end{array} \bullet \begin{array}{c}\text{Average time}\\ \text{to skill level}\\ \text{in weeks}\end{array}\right) =$$

$$\sum_{i=11}^{15} \frac{X_i\,(\text{Hourly wage}_i)}{\sum_{i=11}^{15} X_i} \text{ (Question 4) (Question 14) } \div \text{ (Hourly wage of monitor) } \bullet$$

$$\text{(Question 4) (Question 15a)} = \frac{\$}{\text{Trainee}}$$

Cost of Student Time in Training

$$\left(\begin{array}{c}\text{Hourly wage}\\ \text{of trainee}\end{array}\right) \sum_{i=1}^{19} \left(\begin{array}{c}\text{Weeks to}\\ \text{proficiency}\\ \text{for skill } i\end{array}\right) \left(\begin{array}{c}\text{Trainee hours}\\ \text{per week reading}\\ \text{for skill } i\end{array} + \begin{array}{c}\text{Trainee hours per week}\\ \text{being instructed or}\\ \text{practicing skill } i\end{array}\right) =$$

$$(\$1.32) \quad \sum_{i=1}^{19} (Y_i,1)\ (Y_i,2 + Y_i,3) \quad = \quad \frac{\$}{\text{Trainee}}$$

Indirect Cost of OJT

$$\left(\begin{array}{c}\text{Cost per trainee}\\ \text{for base OJT}\\ \text{monitors}\end{array}\right) + \left(\begin{array}{c}\text{Cost per trainee}\\ \text{for command OJT}\\ \text{monitors}\end{array}\right) \div \left(\frac{\text{Annual cost of updating 291X0 career development course}}{\text{Total number of trainees using CDC in the year}}\right) = \frac{\$}{\text{Trainee}}$$

Cost of Instructor Time

$$\left[\frac{\sum_{i=3}^{7} \left(\begin{array}{c}\text{Number of instructors}\\ \text{with grade } i\end{array}\right) \left(\begin{array}{c}\text{Hourly wage of instructor}\\ \text{with grade } i\end{array}\right)}{\sum_{i=3}^{7} \begin{array}{c}\text{Number of instructors}\\ \text{with grade } i\end{array}}\right] \bullet$$

$$\left[\sum_{i=1}^{19} \left(\begin{array}{c}\text{Weeks to}\\ \text{proficiency}\\ \text{for skill } i\end{array}\right) \left(\begin{array}{c}\text{Instructor hours}\\ \text{per week for}\\ \text{skill } i\end{array}\right) \left(\begin{array}{c}\text{Instructor-to-trainee}\\ \text{ratio for skill } i\end{array}\right)\right] =$$

$$\sum_{i=11}^{15} \frac{(X_i)\ (\text{Hourly wage}_i)}{\sum_{i=11}^{15} X_i} \quad \sum_{i=1}^{19} \quad (Y_{i,1})(Y_{i,4})(Y_{i,5})^{-1} \quad = \quad \frac{\$}{\text{Trainee}}$$

Cost of Remedial Training

$$\left[\frac{\sum_{i=3}^{7} \left(\begin{array}{c}\text{Number of instructors}\\ \text{with grade } i\end{array}\right) \left(\begin{array}{c}\text{Hourly wage of}\\ \text{instructor with grade } i\end{array}\right)}{\sum_{i=3}^{7} \begin{array}{c}\text{Number of instructors}\\ \text{with grade } i\end{array}}\right] \bullet \left(\begin{array}{c}\text{Average weeks}\\ \text{of remedial}\\ \text{training}\end{array}\right) \bullet \left(\begin{array}{c}\text{Average hours}\\ \text{per week of}\\ \text{instructor time}\end{array}\right) +$$

$$\left[\begin{pmatrix}\text{Trainee}\\ \text{hourly}\\ \text{wage}\end{pmatrix}\ \begin{pmatrix}\text{Average weeks of}\\ \text{remedial training}\end{pmatrix}\ \begin{pmatrix}\text{Average hours per}\\ \text{week of trainee}\\ \text{time, on duty}\end{pmatrix}\right] =$$

$$\sum_{i=11}^{15} \frac{(X_i)(\text{Hourly wage}_i)}{\sum_{i=11}^{15} X_i}$$

(Question 12a) (Question 12c)
+ (Question 12a) (Question 12b) (Hourly Wage) = $\frac{\$}{\text{Trainee}}$

Cost of Equipment and Materials

Cost per student of Career Development Course (obtained from Extension Course Institute, Gunter AFB, Alabama).

The outcomes of these equations were summed for each survey and adjusted for attrition by adding a factor equal to question 13. In other words,

$$\text{Total cost per trainee} = \begin{pmatrix}\text{Sum of cost}\\ \text{factor equations}\end{pmatrix} + \text{Question 13} \begin{pmatrix}\text{Sum of cost}\\ \text{factor equations}\end{pmatrix}$$

Discussion

The *Indirect Cost of OJT* should include those costs at base or command level which are associated with OJT in general but which are not easily attributed to any single skill. For some skills the base-level OJT monitors may not be involved. In many skills the cost per trainee of command overhead may be a very small figure. A factor which should be included here is the cost of updating the Career Development Course, but only for those skills with an annual Trained Personnel Requirement of 100 or more. This cost is included here because both technical school and OJT trainees use the course—the cost should be distributed evenly among all users.

In the *Cost of Instructor Time*, the instructor hourly wages are a weighted average of instructor wages within the communications center.

Cost of Delayed Entry into 291X0 Training is unique to this skill because of the requirement for a security clearance prior to entry to most communications center. Normally, there is little delay prior to start of training.

Remedial training is conducted both on and off duty. The assumption made was that it is only on-duty remedial training which results in a loss of productivity. Off-duty time was not included in the *Cost of Remedial Training* because, although it certainly costs the trainee something, the Air Force loses nothing directly.

The only equipment and materials used in OJT for this specialty are the Career Development Course materials. The interviews indicated that increased equipment maintenance and increased utilities consumption due to OJT were nil. Extension Course Institute, Air University, provided an estimate of the cost of materials and administration of a Career Development Course. Data were not available for the specific course concerning the 291X0 specialty.

APPENDIX III. COST OF TECHNICAL TRAINING SCHOOL

To obtain a cost estimate of the technical training school course corresponding to 291X0 OJT, a computer model was developed by RAND Corporation for estimating resources and costs of the training (Allison, 1970). Input data for the model were provided by Sheppard Air Force Base Technical Training Center on man-hours, facilities, maintenance, and materiel.

A copy of the last page of output of the computer program is shown as table 0. The appropriate cost estimate is indicated for the cost factor Cost per Graduate, Student type 1.

The technical training school cost categories generally contain greater detail than the OJT cost factors because more detailed data are available for technical training school.

OJT Cost Factors	Tech School Cost Categories
Student Time	Pay and Allowances (Students)
Instructor Time	Pay and Allowances (Instructors and Supervisors)
Equipment and Materials	Pay and Allowances (Media and Training Aids) Training Aids, Maintenance, Materiel, and Service Media, O&M, Materiel, and Service Supplies and Services
Cost of Delayed Entry into Training	Pay and Allowances (Students)
Remedial Training	Pay and Allowances (Students and Instructors)
Records Management	Pay and Allowances (Training Administration) Command Overhead
Indirect	Pay and Allowances (Indirect)

In Table 7, the nonrecurring costs items in the technical training school cost output are zero because these costs are to be used for comparison of alternatives. Nonrecurring costs for facilities which already exist are not valid for this purpose because the facilities will likely remain whether or not the technical school remains. However, if, for example, the student load for technical training school were to increase beyond present capacity, the cost of required additional facilities would have to be included in this cost category.

Some of the cost categories appear more than once beside OJT Cost Factors. For instance, Pay and Allowances (Students) appears beside both Student Time and Cost of Delayed Entry into Training because the computer model lumps the time for Personnel Awaiting Training and the actual time for student training into one factor, Student Time.

The Command Overhead factor in the computer output has no corresponding OJT cost factor because this cost was negligible for Communications Center Operations OJT. This may not be true of other Air Force specialties.

Personnel at the technical training school maintain and update the Career Development Course used by both technical training students and by OJT trainees. The cost of this would exist whether or not OJT existed because OJT trainees make use of the service. However, because the cost is not negligible, and because this cost is included in the technical training school model, it was prorated based on a fiscal year Trained Personnel Requirement estimate of 2,000 and included for OJT under the Indirect cost factor.

One incorrect aspect of this computer model is that the cost of student time spent in Personnel Awaiting Training and Personnel Awaiting Assignment status is computed based on the student's wages while in school. It should be based upon his wages after he leaves school, however, because the productivity foregone as a result of these delays occurs as the student's graduation point is moved into the future. In this sense, the technical training school cost estimate of $2,670 is a slight *underestimate of the actual cost, although the difference will probably not amount to more than $100.*

Under Cost per Graduate in the computer output, Student type 1 represents Air Force enlisted personnel, while Student type 2 represents Civil Service employees. The difference in cost for these two groups is due to differences in delay time (entering and leaving the course) and attrition rates.

Table 7. **Technical Training Resource and Cost Model**

Cost Factor	Costs in thousands of dollars		
	Total	Variable	Fixed[a]
Nonrecurring Costs			
Media	0	0	
Training aids	0	0	
Facilities	0	0	
Classrooms	0	0	
Laboratory	0	0	
Other	0	0	
Other	0	0	
Subtotal nonrecurring	0	0	
Recurring Costs			
Student TDY and PCS	316.00	316.00	
Instructor training	14.00	14.00	
Pay and allowances	1,904.00	1,508.00	396.00
Students	653.00	653.00	
Instructors and supervisors	262.00	262.00	
Media and training aids	91.00	91.00	
Training administration	160.00	14.00	145.00
Indirect (base admin, supt)	738.00	488.00	250.00
Trng aids mtce matr and serv	5.00	5.00	
Media O+M matr and serv	0	0	
Supplies and services	160.00	110.00	51.00
Command overhead	164.00	164.00	
Other	0	0	
Subtotal recurring	2,563.00	1,952.00	611.00
Total Cost	2,563.00	1,952.00	611.00
Cost per Graduate[b]	2.56	1.95	.61
Student type 1	2.67	2.06	.61
Student type 2	1.90	1.29	.61
Student type 3	.00	.00	.00
Student type 4	.00	.00	.00
Student type 5	.00	.00	.00

[a]Fixed costs are costs which will not vary for the school, department, branch, or course regardless of any change made to the course or the number of students trained. Fixed costs for the school, department and branch are allocated to courses on the basis of numbers of student weeks.

[b]Cost per graduate by student type determined on the basis of actual academic student weeks and pay and allowances by type of student.

Alternative cost estimates for technical training school courses are available in Air Force Manual 172-3, *Air Force Cost Planning Factors*. However, these reported costs are not as accurate for cost comparison purposes as the cost model discussed here because school operation costs and man-hours are not allocated in detail to the individual course level. While this may mean an error of only $100 to $200 per graduate, there is no need to accept this error when a more accurate, low-cost alternative method is available.

APPENDIX IV. ADDITIONAL COST ASSOCIATED WITH TECHNICAL SCHOOL TRAINING

The OJT-trained 3-level continues to progress after reaching his skill level. This is true of the technical school graduate also, but he does not have the workload capability of an OJT-trained 3-level until a few weeks after his arrival on the job. This difference in relative productivity is depicted in Figure 2. The shaded area can be thought of as representing the total productivity loss associated with the inability of the technical school graduate to assume full workload immediately after arrival. Productivity is measured relative to the OJT-trained 3-level, assuming that the OJT-trained 3-level has 100 percent of the productivity required of an Air Force 3-level in the specialty.

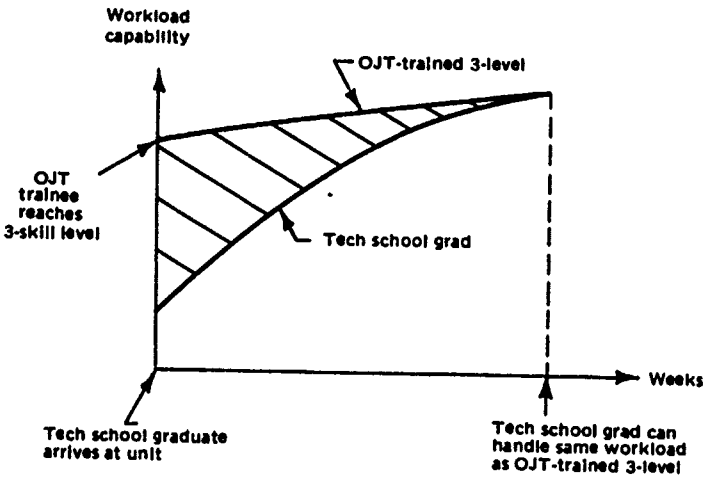

Fig. 2. **Comparative workload capability vs. time for OJT and technical school trainees.**

With this assumption the mean answers to survey questions 11a and 11b (see Section III. Analysis of Results) can be used. In other words, the technical school graduate starts out with 32.16 percent of the productivity of an OJT-trained 3-level and reaches 100 percent in an average time of 4.25 weeks.

The OJT-trained 3-level undoubtedly increases his productivity over the 4.25 weeks, but *how much* is a very complex question. Therefore, another assumption is made to make the problem manageable—that the OJT-trained 3-level has constant productivity for that period of time. This forces the OJT curve to appear as shown in Figure 3. It is not clear whether this assumption results in an overestimate or an underestimate. The ratio of the shaded area to the area of the total rectangle provides a reasonable estimate of the percentage of the 4.25 weeks which was unproductive.

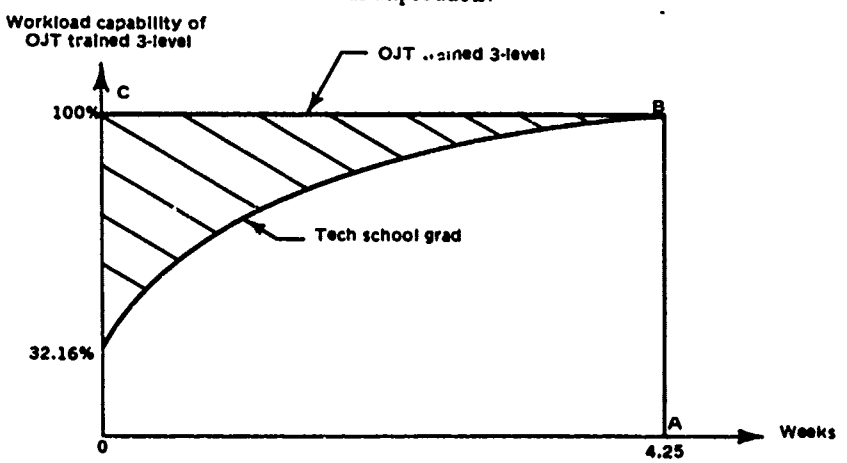

Fig. 3. **Comparative workload capability vs. time using OJT 3-skill level as base.**

Assume the curve for the technical school graduate is exponential, *i.e.*, of the form

$$Y = C_1 + C_2(1 - e^{-\alpha x})$$

where Y is the percentage of an OJT-trained 3-level's workload and x is weeks. The shaded area can be obtained by subtracting the area under the curve from the area of rectangle OABC. The ratio of the shaded area to rectangle OABC could then be multiplied by 4.25 weeks and the 3-level's weekly wage to obtain a cost estimate of the unproductive time. A plotted graph of the curve is shown in Figure 4.

Solution for α

$$Y = 32.16 + 67.84\,(1 - e^{-\alpha x})$$

$$Y(o) = 32.16$$

$$Y(4.25) = 99.9$$

$$\alpha = 1.37$$

thus

$$Y = 32.16 + 67.84\,(1 - e^{-1.37})$$

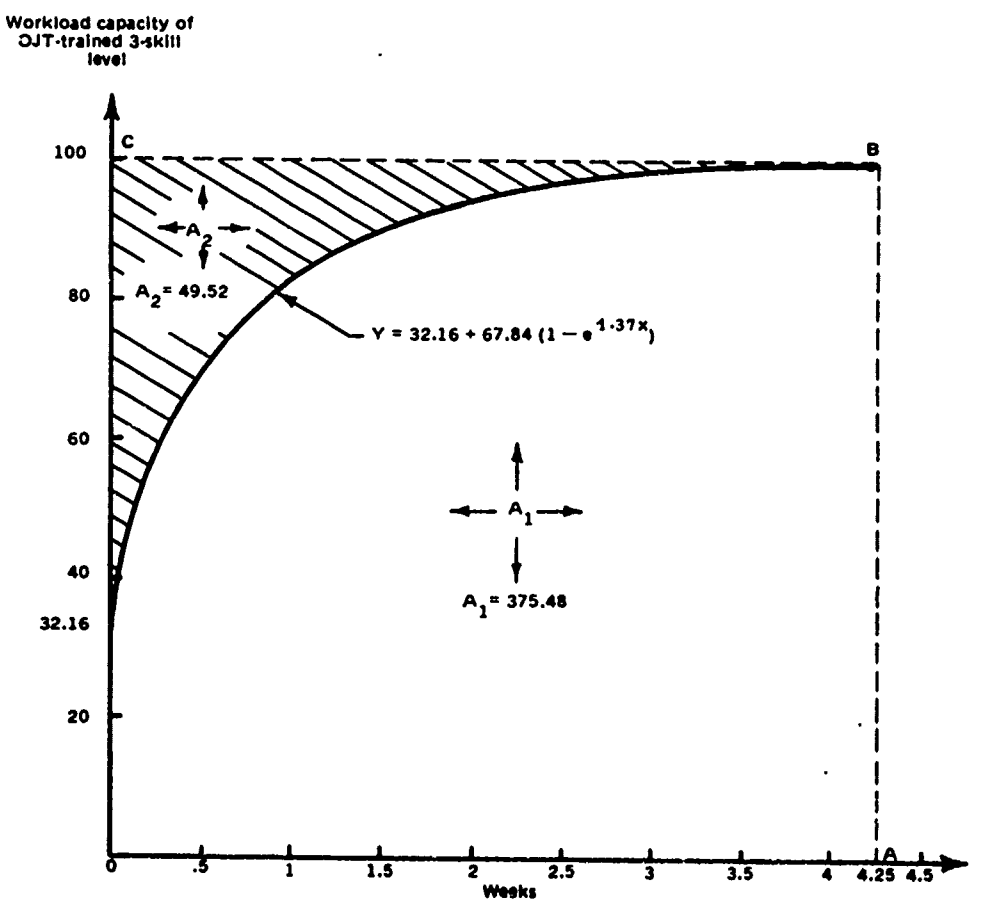

Fig. 4. **Solution showing workload capability vs. time using OJT 3-skill level as base.**

Solution for area under curve

$$A_o = \int^{4.25} (32.16 + 67.84\,(1 - e^{-1.37x}))dx$$

$$A_1 = 375.48$$

Solution for shaded area

$A_1 + A_2$ = Total area = (100) (4.25) = 425

$$\therefore A_2 = 425 - A_1 = 49.52$$

$\frac{A_2}{A_1 + A_2}$ = 13% of 4.25 weeks spent in reaching the proficiency of an OJT-trained 3-level.

Estimated additional student cost of technical school graduate

$$\left(\frac{49.52}{425}\right)\left(4.25 \text{ weeks}\right) \bullet \left(40\frac{\text{hours}}{\text{week}}\right)\bullet\left(1.62\frac{\$}{\text{hour}}\right) = \$33.26$$

Instructors must also spend time instructing technical school graduates to "get them into the system." To measure the cost of this instructor time, it was assumed that instructors spend an amount of time equal to that spent by the technical school graduates. This means that instructors spend $\frac{A_1}{A_1 + A_2}$, or 13 percent of 4.25 weeks as an instructor. The average instructor wage is $3.48 per hour (a weighted average using questions 10a and 10b from the survey).

Thus, the cost of instructor time is

$$(.13)\ (4.25 \text{ weeks})\ (3.48\ \frac{\$}{\text{hour}})\ (40\ \frac{\text{hours}}{\text{week}}) = \$76.90$$

This cost, plus the estimated cost of student time, brings the total cost estimate for technical training school up to $2,780.

APPENDIX V. COMMUNICATIONS CENTER OPERATIONS OJT SURVEY

INSTRUCTIONS

1. The Communications Center Supervisor/NCOIC should complete this survey. If this person is unavailable, it should be filled out by the OJT Monitor. Approximately one (1) hour will be required to complete the survey.

2. When answering the questions, have a Job Proficiency Guide (STS) handy to refer to.

3. The person who fills out this survey is encouraged to ask for the help of others, such as the OJT Monitor or an instructor when uncertain about the answer to a question.

4. This survey should be completed and returned in the attached self-addressed envelope not later than 2 April 1971.

5. If there is difficulty in deciding what information is being asked for in any question, contact Lt Dunham, Lackland AFB, at 473-4106 (AUTOVON).

BACKGROUND INFORMATION

NAME (Last, first, middle initial) _____

GRADE

E-4_____,E-5_____,E-6_____,E-7_____E-8_____,E-9_____

Job Title_____

Social Security Number_____

Organization _____

_____

Base or Installation_____

Total Months in Present Job _____

Total Months at Present Base _____

Duty Telephone Extension _____

CHECK THE EQUIPMENT OPERATED IN YOUR COMMUNICATIONS CENTER:

AN/FGC 20 AND 25 TELETYPEWRITERS	☐
AN/FGC 38X/39 TELETYPEWRITER RELAY EQUIPMENT	☐
ASR MODEL 28 TELETYPEWRITERS	☐
CARD-PUNCH UNITS	☐
COMPOUND TERMINAL UNITS	☐
DATA CARD INTERPRETER	☐
FACSIMILE	☐
MAGNETIC TAPE TERMINAL EQUIPMENT	☐
MANUAL AND AUTOMATIC SWITCHBOARDS	☐
MODE V TELETYPEWRITER TERMINAL CONTROL UNIT 12000 8-A	☐
MODEL 19 TELETYPEWRITERS	☐
MULTIPLE ADDRESS CONSOLE CABINET 7666A	☐
PLAN 55 AUTOMATIC RELAY EQUIPMENT	☐
TSEC/KG-3 AND KG-13	☐
TSEC/KL-7	☐
TSEC/KL-47	☐
TSEC/KW-7	☐
TSEC/KW-26	☐
TSEC/KW-37	☐
OTHER (Specify)_____	☐

291X0 OJT SURVEY

1. Approximately when (give month and year) did your Communications Center last conduct OJT to the 3 level for AFSC 291X0? _____ _____
month year

2. When a man (or woman) first arrives at your Comm Center directly from Basic Military Training, it may take some time before he actually begins training and work inside the Comm Center, even though his "date of entry" to training may be the same as his reporting date. Part of this delay is due to personnel processing, while any further delay may be due to the need to wait for security clearance before entering the Comm Center. Approximately how many weeks does it take before the newly arrived "helper" actually begins OJT? ____weeks.

3. There is also delay in entering training associated with the arrival of a 3-level from Technical School at Sheppard Technical Training Center. In addition to personnel processing, familiarization with procedures specific to your Comm Center may be necessary before he/she actually begins 5 level training. On the average, this delay is ____weeks

4. Due to the "minimum time" requirement to the 3 level and to delays in paperwork, there is often a difference between time of award of the 3 level and the actual time the trainee takes to reach the required level of proficiency in all skills. Based on your experience, what is the average number of weeks it actually takes for a "helper" to reach the proficiency required for a 3 level? _____weeks.

5. What percentage of the 3 level trainees fail the Apprentice Knowledge Test (End of Course Test) the first time they take it? ____%

6. Under normal operating conditions, how many eight-hour shifts per day does your Comm Center operate? _____shifts per day.

7. How many trainees do you have going to the 3 and 5 level in your Comm Center? _____3 level trainees. _____5 level trainees.

8. In addition to the trainees you now have responsibility for and ignoring the limit on authorized number of personnel, how many more 3 level trainees could your Comm Center train right now without significantly reducing the effectiveness of the Telecomm operations? _____3 level trainees.

9. If you had to lose a qualified 5-level for each new 3-level trainee ("helper"), how many more 3 level trainees could your Comm Center train right now without significantly reducing the effectiveness of the Telecomm operations? _____ 3 level trainees.

10. Assuming your Comm Center had to train the sum of questions 7 and 8, list the number of instructors in each grade who would be responsible for 3 and 5 level OJT: E-7___;E-6___;E-5 ___;E-4___ ;E-3___.

11. The newly arrived Tech School-trained 3-level is not as productive at first as the OJT-trained 3-level is, although he may soon close the gap.

a. In your estimate, what percentage of the workload of an OJT-trained 3-level can the Tech School graduate handle immediately after his arrival? _____%

b. How many weeks does it take before the Tech School-trained 3-level works with as little supervision as an OJT-trained 3-level? _____weeks.

c. After both types of 3-levels are awarded their 5-level, on the average do you consider either to have superior performance?____ yes;____no. If your answer was 'yes,' which type of 3-level do you consider to have better performance?___ OJT-trained to 3 level;____Tech School-trained to 3 level.

12. If extra (remedial) training is conducted in your Comm Center for trainees who fail the Apprentice Knowledge Test (End of Course Test), answer the following questions:

a. On the average, how many weeks of additional training are given to airmen who fail the AKT before they take the test again? ____ weeks.

b. How many hours per week, normal duty hours, does the trainee spend engaged in this remedial training? ___ hours per week.

c. How many hours per week, normal duty hours, does the instructor (trainer) spend conducting this extra training? ____ per week.

d. How many hours per week, overtime, does the trainee spend in extra training? ____ hours per week.

e. How many hours per week, overtime, does the instructor spend conducting extra training? ____ hours per week.

f. What is the average grade of the instructor who conducts this extra training?____.

13. Of those trainees enrolled in OJT in the last year, what percentage failed to upgrade to the 3 level?____%

14. During the training period for 3 level OJT, the instructor (trainer) must spend some time keeping training records up to date. On the average over the whole training period, how many hours (or fractions of hours) per week does the instructor (trainer) spend in record keeping for one trainee?_____hours per week.

15. The OJT Monitor for your Comm Center must also spend some time reviewing records. How many hours (or fractions) per week does the OJT Monitor spend reviewing the records of one trainee? _____ hours per week. Grade of OJT Monitor? _____.

16. The Career Development Course is designed to be used by all OJT trainees, 3 and 5 level, but since equipment and procedures vary among Communications Centers not all of the CDC is relevant to the operations of your particular Comm Center. Roughly what percentage of the material covered by the CDC is relevant to the operations of your unit?____%

17. What is the total number of personnel in your Comm Center at this date?____personnel (officer, enlisted, civilian).

18. In this question, you are asked to provide estimates of training time spent on various items in the Job Proficiency Guide (STS). The figures which you give will necessarily be average figures based on your experience. When you lack experience or cannot recall enough information to properly answer any part of this question, you are encouraged to consult with others in your Comm Center who would have more recent experience or who have been in closer contact with the training. Referral to a Job Proficiency Guide (or Specialty Training Standard) will help you give accurate information. If you refer to the items following, you will see that training time to 3-level proficiency for each skill is broken down into categories defined as follows:

Weeks to Proficiency: The number of weeks it takes the average trainee to reach 3-level proficiency in that skill.

Trainee Hours per Week Reading: This is the average number of hours per week during the weeks spent becoming proficient in this skill that the trainee spends reading material relevant to this skill.

Trainee Hours per Week OJT: During the time spent learning this item, this is the number of hours per week the trainee spends learning the different aspects of this skill, in addition to reading.

Instructor Hours per Week: During the weeks spent by the trainee in learning this skill or knowledge, this is the number of hours per week spent by the instructor (trainer) in teaching (or lecturing) all trainees. This may differ from "Trainee Hours per Week OJT" in some cases, such as typing.

Trainees per Instructor: This is the average number of trainees handled by an instructor for a particular skill. This may be the same for all skills, but not necessarily.

As an example, look at the first item, "Mission." We'll assume that out of the weeks spent by the "helper" in acquiring 3-level skill, in only one week was there formal training about "Mission." So you would put a '1' next to "Mission" under "Weeks to Proficiency." This is not an extensive subject, so probably not much time is spent on it. For the sake of an example, we'll say that for the whole week the average trainee spends one hour reading and two hours being shown the different equipment and procedures and how they relate to the mission of the Major Command and the Air Force. So you would put a '1' under "Trainee Hours per

Week Reading" and '2' under "Trainee Hours per Week OJT." We will also assume that the instructor was with the trainee(s) for their two hours of OJT and that he usually handles two trainees while teaching the item. So you would put a '2' beside "Mission" under "Instructor Hours per Week" and a '2' under "Trainees per Instructor." The information for this item would look like this:

	Weeks to Proficiency	Trainee Hours per Week Reading	Trainee Hours per Week OJT	Instructor Hours per Week	Trainee per Instructor
1. Mission	1	1	2	2	2

Again, it is understood that these figures are not exact. Just give the best estimates you can about these average times.

	Weeks to Proficiency	Trainee hours per Week Reading	Trainee hours per Week OJT	Instructor Hours per Week	Trainees per Instructor
1. Mission					
2. Communications Security					
3. Safety					
4. Publications					
5. Supervision & Training		NOT APPLICABLE			
6. Typing					
7. Communications Instruction – General					
8. Cryptographic Operations – (only what's in CDC)					
9. DCS Teletype and Autodin Tributary Operation					
a. Routing					
b. Services					
c. Traffic handling					
1) Incoming Narrative Data					
2) Outgoing Narrative Data					
10. DCS Teletype and Data Relay Station Operation					
a. Torn tape operation					
1) Inspection					
2) Processing					
3) Routing					
4) Transmission					
b. Autodin Switching Center Operation (that which the 291X0 is responsible for)					
11. Weather Relay Operation		NOT APPLICABLE			
12. Telephone Switchboard Operations					